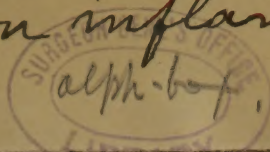


WATTERS (J. H.)

An essay on inflammation x



AN ESSAY
ON
INFLAMMATION:

THE TENTH OF A SERIES OF ARTICLES PUBLISHED IN THE
ST. LOUIS MEDICAL JOURNAL,

ON
"LIFE,"

BY

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No. X. *Application of the Theory of Life, presented in the
previous Nos., to the phenomena of Inflammation.*

It will be remembered by those who have taken interest in the articles on "Life," which have appeared from time to time in the St. Louis Medical Journal, that from a consideration of the phenomena of life I arrived at the conclusion that all physical phenomena depend upon two primary conditions,—*Form* or *Adjustment* and *Motion*. In the last article, which appeared two years since, I promised in the next No. to invite attention to the phenomena of Disease as *confirming* this abstract proposition applied to a general theory of Life; but as I had concluded to present the whole subject to the public in a different form, and as I had already published the main points in my thesis, this promise was not fulfilled. Though the same reasons for publishing nothing more upon the subject in the Journal still exist, yet, as the proposed work can not be prepared for the press for

some time, the occasion of this article will appear from what is to follow. There justly exists so strong a presumption against any new theory of life, that one has no reason to expect to be listened to on such a subject; and how great soever the author's ardor and conviction of the truth of his theory, this does not in the least lessen the presumption against him. The object of this article is not to prove the theory true, (this I have attempted on other occasions,) but merely to remove that presumption against it which exists against every new theory. If this should be accomplished, the love of truth and justice which exists in every true lover of knowledge will insure at least an audience. It is not the result of prejudice (as innovators generally would have us believe), that little attention is given to new theories, but it is rather because so much is promulgated which is altogether visionary, that prudent men have become suspicious. But if men run into the other extreme, and infer that, because so many false theories have obtained, all new theories must be false, they are in this prejudiced; for, really, "novelty is the only opening for hope where all theories have failed." Though the presumption is that a man is innocent until he is proved guilty, this presumption does not prove him innocent.

I was led to the theory of Life, which I have been endeavoring to develop for the last eight years, by the following facts and process of reasoning: A seed may be preserved an indefinite time without undergoing change; but when heat, air and moisture are applied to it, it germinates and a living plant is developed. But the tendency of heat, air and moisture is to produce decay in a seed, as in other organic matter. Why is it, therefore, that these conditions occasion Life when their natural tendency is to produce decay? To account for this, many have assumed a "dormant vitality" in the seed during its inactive condition, and that these conditions *stimulate* the dormant vitality into action. But no force can be either inactive or stimulated; * hence this theory of dormant vitality will not do. Then, the advocate of the 'dormant vitality theory' says, Heat, Air and Moisture must produce decay if there be no force to resist. This I admit; but, admitting this, then decay must be the vital motor,—action and reaction are equal and in oppo-

* See my Thesis, published 1851.

site directions,—the *de*-oxydation of an electrolyte is opposite and equal to the oxydation of zinc,—a falling stream is the *motor* of any machinery the human mind may construct. This is the leading idea in my thesis, an application of which is therein made to the various phenomena of living beings. Here it will be observed, that I deny nothing assumed by the advocates of a “dormant vitality,” except the necessity of assuming this absurdity merely because heat, air and moisture produce decay of organic matter.

Now, if by a different class of facts and another process of reasoning the same general proposition is arrived at, this circumstance strongly confirms the original proposition. I will here indicate in a few words the general process developed in the earlier Nos. of this series of articles, that those acquainted with the various theories of life may at once see wherein I agree with, and wherein I differ from, others.

In nature, we find every thing in ceaseless motion,—the earth around the sun and upon its own axis, and different parts in relation to other parts upon its surface. But in the midst of all this we discover order, law, or special modes of action. When we turn our attention to living beings, we can not but remark unspeakable intelligence, wisdom and design in the various organic actions. The eye, for instance, is formed in the womb perfectly adapted to the laws of light, though there is no light in the womb where it is formed. From the consideration of this class of facts, it was natural for men even in very early times to assume the existence of a special agent in each living organism, endowed with sufficient intelligence and wisdom to direct organic action. Though various names have been given to this assumed agent, in all essential points the same is assumed at the present time even by many of the most scientific.* Many do not name it audibly; nor even do they whisper it to themselves; but they feel at perfect liberty to endow it with all imaginable properties to meet every emergency.

Others again, whose attentions are directed to chemical processes,—to the regular processes in living beings,—to independent cell life, &c., see nothing but “law” or regular “modes

* See Agassiz,—Contributions to the Natural History of the United States, Vol. I.

of action." These deny a special intelligent vital force, and refer all vital phenomena to chemical and physical forces. While the former neglect to notice the objections to their intelligent agent, but assume it from a supposed necessity, these latter neglect to take into account the development of special forms, and other evidences of intelligence and wisdom in the actions in living organisms. Of these, some lay aside the whole question of causes, and contend that laws and modes of action are the goal of science. Others contend that as matter is believed to have been originally endowed with attraction and chemical affinity as inherent properties, so it was originally endowed with vital properties which are manifested only in organization. Some suppose because heat is an essential condition of life and regulates the degree of vital action within certain limits, that therefore heat is the vital force.* Others again contend that heat, acting upon an organism as a special "material substratum," is converted or metamorphosed into a special vital force. Now it is apparent that, as necessitated physical forces can not change themselves, their direction, or mode of action, these various hypotheses do not reach or even approach the phenomena from a consideration of which so many philosophers have, from a supposed necessity, assumed an intelligent vital agent. Each of the above classes of philosophers views the phenomena only partially; hence the theory of the one does not include the facts of the other.

Now the motions of necessitated physical agents may be directed so that definite results will be effected, manifesting design, wisdom and intelligence by two, and only two, possible means. One of these means is the direct guidance of an intelligent voluntary power; the other—the only possible alternative—is special *Forms* or *Adjustments*. To illustrate; we, as intelligent agents can accomplish our objects either directly, or by means of necessitated physical agents, through special forms or adjustments, or, as usually termed, machinery. As observed, a large class of philosophers assume, from a supposed necessity, the *direct* action of an intelligent power to guide vital motions. If, with the second class, we deny the direct action of an intelligent force in the production of vital phenomena, we are compelled, by

* See S. L. Metcalfe on "Caloric, its Agency in the phenomena of Nature."

the laws of mind, to assume special forms or adjustments to *direct* the motions both in the living organism and in inorganic nature. Whether we assume a "dormant vital force," or vital forces originally given to matter, or chemical affinity, or heat, or heat metamorphosed into a special vital force, or any thing else, if we deny intelligence and volition to it we are still compelled to make form or adjustment the condition of the special mode of motion. When, for reasons elsewhere given, I deny the existence of an intelligent agent in each organism to guide motion, I assume special Forms as the condition of special modes of motion. In this, I equally abandon and condemn every assumption of absolute force,—whether chemical, physical or vital,—as the condition of special modes of physical change.

But Form has no power either to originate or to destroy motion. It is said, therefore, *as* decay is the natural result of the inherent affinities of inorganic matter, Form has no power to resist these chemical affinities and to produce life. Now as voluntary power and special forms are the only two possible conditions of special modes or processes of change, decay can no more be the result of inherent chemical affinities than can life. When it was believed that all heavy bodies had a natural tendency to move in one direction in space, it was contended that men, if on the opposite side of the earth, must be sustained by some supernatural power, or that they stick on like flies do to the ceiling. But when it was found that to our antipodes "downward" is as much toward the centre of the earth as it is to us, it was concluded, that heavy bodies do not have a natural tendency to move in one direction in space. The error of the ancients was in beginning by assuming, from appearances, as a fact what was not a fact. So, as it is believed that organic matter has a natural tendency to decay from inherent chemical affinities, it has been concluded that there must be some supernatural power in a living organism to resist chemical affinities and produce life. I reason thus rather,—if the natural tendency of organic matter to decay when under the influence of the objective conditions of life results from inherent chemical affinities, then there must be some peculiar vital force to resist the chemical forces in a living organism; but there is no peculiar vital force; therefore the natural tendency of organic matter to decay is *not* the result of inherent chemical

affinities. Here, too, the error has been that in the beginning of chemical science inherent chemical affinities were assumed, from appearances, as a fact,—an “ultimate fact;” and those who have contended that vital phenomena are to be referred to chemical laws, have failed to make out a consistent theory *because* they had already restricted chemical laws to too narrow limits by this “false fact” of inherent affinities.

Thus the way is cleared to a consistent theory;—that the direction or mode of physical change is *always* to be referred to Form, when it can not be referred directly to volition.

But it is said, as Form confessedly has no power, whence do you get motion? You forget,—as Form has no power, what is there to stop or destroy motion? I therefore waive this question as to the *origin* of Motion, just as the natural philosopher or chemist waives the question as to the origin of matter. *You* say with me, that heat, air and moisture occasion decay in organic matter; I say, here is motion, and that the vital motions are reciprocal with antecedent motion, just as the motions of a factory and steam engine are reciprocal with the oxydation of wood. Upon what does the universe rub, or to what outside can it communicate its motion?

But, it may be said, that it is difficult to comprehend an adjustment so exquisite as to determine vital phenomena. This I most willingly admit; but remember that all who deny the direct guidance of an intelligent voluntary power, are bound to assume an adjustment no less exquisite. It is difficult to comprehend the forms in a factory or machine shop, yet these are the work of the human mind; therefore the difficulty to comprehend the forms of nature is no argument against them when *they* are the work of Omniscience. It is to be wondered if men really imagine that they comprehend any more by assuming special vital forces and chemical affinities.

Thus we come to the abstract proposition that Form and Motion are the conditions of all physical phenomena. And by these two classes of facts and processes of reasoning we arrived at the same general conclusion,—that the decay in an organism, occasioned by heat, air and moisture, is a condition of life, being an antecedent motor with which vital motion is reciprocal. From this coincidence, I claim that the presumption against this theory

because of its novelty is greatly removed, and that, so far, it is worthy the attention of thoughtful men.

But, secondly, this generalization denies no *fact*, but rather embraces the facts of all other generalizations or theories of life; and this tends to remove the presumption against it. It excludes none of the facts of those who, from a supposed necessity, assume a special intelligent vital force; and, at the same time, it includes all the facts of those who base their theories upon the laws, regular modes of action, and necessity, observed in the organic motions. It admits the evidences of intelligence, wisdom and design, but denies the direct guidance of an intelligent power; it admits that vital phenomena are included in chemical and physical laws, but denies that these phenomena can be crowded within the limits of the present conception of these laws,—it would rather extend the confines of chemistry and physics so as to embrace life. This generalization embraces the fact that the eye is formed in the womb adapted to the laws of light, and that vertebrate animals have the same idea or type of structure over the surface of the earth at the present time as well as in the most remote periods of their existence; yet, in making form the immediate guide of vital motions, it embraces also the fact that “each cell lives for and by itself,” and that lungs may be perfectly formed in an acephalous foetus. In making form and motion the conditions of all physical phenomena, it includes all the *facts* of the “correlation theory,” but denies that heat, light, electricity, chemical affinity, vital force, &c., are correlative or convertible one into the other, more than are oxygen, hydrogen and carbon.

But, not to dwell upon these points, we now pass to the third argument, which is the especial occasion of this essay, by which I hope to elicit sufficient interest to occasion the thoughtful consideration of the generalization advocated in my thesis and in this series of articles.

One of the strongest verifications of a theory is the clear explanations it gives of facts and phenomena not contained in the original generalization, when used and applied for that purpose. I have heretofore pointed out the application of this theory of life to various chemical and vital phenomena, and I here affirm that in every instance the explanation, or co-ordination of facts, thus reached, was clear and satisfactory to me at least. I merely

make this affirmation here without caring whether any one regards my opinion or not. But thoughtful men (and I regard the attention of such only) must become interested by the fact that the theory of inflammation, which, in my thesis (published 1851), I deduced directly from this generalization of life, is formally presented in the last No. of the British and Foreign Medico-Chirurgical Review, (July, 1858,) as clear and satisfactory, and as co-ordinating the facts as no other theory of inflammation does. The author of the article referred to says: "It may seem strange indeed how so natural an interpretation of the facts should have escaped the sagacity of those observers who have especially noticed the intimate connexion between functional activity and inflammation, and who have remarked that excessive function of an organ leads to or becomes inflammatory action by such continuous gradation that the line can not be drawn between them."* I will here republish what is contained in my thesis upon this subject; and let it be remembered, that this was there introduced to show that the phenomena of disease confirm the general proposition, that decay or disintegration is the vital motor,—not that it is the "vital force," which is assumed as the cause both of motion and the specialty of vital motion, but that it is the motor or direct antecedent with which vital motion is reciprocal, the specialty or direction of motion being determined by the form or adjustment. It will be observed, too, that in this I merely contend that in the operations of nature the cause of motion and the cause of the mode or direction of motion are as distinct as in the operations of art,—the one being adjustment, the other, antecedent motion. The following is the application of this doctrine to the phenomena of disease, made in my thesis: †

"6th. Arguments from the phenomena of the organism in a *diseased condition*."

"The phenomena of the healthy and diseased actions considered together, are as the perpendiculars bisecting the chords of *two* arcs of a circle, which indicate its centre. All the phenomena of life meet in one point, which is the central law; our present ob-

* See Hinton on the "Theory of Inflammation;" Brit. and Foreign Medico-Chirurgical Review, July, 1858.

† See "An Essay, on Organic or Life Force;" written for the degree of Doctor of Medicine in the University of Pennsylvania. By J. H. Watters, A. B. Published by Lippincott, Grambo & Co.—1851.

ject is to trace them to this point, and find where they meet. In tracing the phenomena of disease, let us consider

“*First—Depression.* In the healthy condition there is a constant balance preserved between decay and renewal. But, for the preservation of this balance it is necessary that *all* the functions should be performed in a fixed relation to each other; there can not be proper renewal of the tissues unless the blood be properly elaborated, and be acted upon by the proper forces to cause the assimilation. For the proper exercise of all the functions, it is necessary not only that there should be a supply of proper food to be converted into blood, but that the whole system should be under the influence of certain agents called “Vital Stimuli;” the chief of which are air and heat. A reduction of any one of these conditions produces a *depression* of the vital actions below the proper standard. It will be observed that those agents which are called vital stimuli are the conditions of decay; and, therefore, it is the reduction of the conditions of decay that depresses the vital actions, and, consequently, the vital actions must be dependent upon decay.

“But the mere depression of the vital actions is not a disease; it is a disturbance of the balance between decay and renewal that constitutes the disease. It is evident that a function may be performed *slowly* without being *deranged*, as a man may work slowly and yet do his work well. If decay be slow, it is necessary that the nutritive functions should be below the natural standard, to preserve health. If decay and the nutritive actions be both *equally* below the natural condition, the actions that do take place are still normal. But, in *warm-blooded* animals it is seldom that depression exists for any length of time without being either the cause or effect of actual disease, from the simple fact that the ordinary causes only produce *partial* depressions; this disturbs the due relation, and consequently there is *derangement* of functions. The ordinary standard of actions is that which is determined by the ordinary circumstances; but there is no reason to believe that the existing circumstances are the *only* ones under which the actions could be *healthy*. For instance, if the atmosphere contained several per cent. less oxygen than it does, there is every reason to believe that its simple effect would have been to reduce the *standard* of vital actions. In a patient recovering from an acute disease, we have an example of depression without disease. The actions here are below the ordinary standard, yet they are healthy. The organism is so much reduced that there is but little to become oxydized, and I contend that it is on this account that the vital actions are proportionally low, and not because the “vital principle” has been *sick* or *asleep*. Again, in old age the energies gradually fail, and the vital actions become more and more reduced, until at last life may cease without

disease. Here the organism becomes more and more firm, and less easily acted upon by the ordinary agents, until at last the oxydation is not sufficient to keep up the necessary actions of life, and the individual dies. Again, the vital actions may be reduced from hemorrhage, but if the patient be kept perfectly quiet, so that *all* the functions are equally reduced, there would be depression without disease. Here the blood is reduced, which is both the great oxydizing agent and the organizable material; so the proper relation may still be preserved among all the functions. These examples are sufficient to show that mere depression of the vital actions does not constitute disease; but in cold-blooded animals the examples are more striking. In these there is no particular *temperature* at which the healthy vital actions take place, as in the warm-blooded, and the animal is dependent upon external circumstances, and not upon internal chemical action, for its temperature; so, as heat is a necessary agent to decay, cold is an ordinary cause of *universal* depression in these animals. They become torpid, but not diseased, from the reduction of temperature; they may be frozen, and life entirely extinct, but, if heat be properly applied, life begins again. From these facts it is evident that it is the diminution of decay that depresses the vital actions, and, consequently, the forces which produce vital actions are evolved in the decay of an organism; it is also evident that health is entirely distinct from vital activity—that there is no standard of vital activity apart from the circumstances under which the vital actions take place, but there is a *relative* functional activity from which health is inseparable. Application of this fact will be made under the next head.

“*Secondly—Of Increased Action.* As those causes which diminish decay *decrease* the vital actions, so those causes which increase decay increase the vital actions. Now, to say the least, it seems absolutely impossible that the same causes which produce decay directly in *all* organic matter, should, under any circumstances, *directly* produce a contrary action. But the facts are—it is *only* when an organism is placed under the influence of circumstances which tend to cause its destruction that life becomes manifest, and the increase of these increases life action; so it seems impossible to believe anything else, if we were so disposed, than that these causes produce life action *indirectly* through decay, which is their natural and only tendency. But the inquirer after truth will never find it if he look through a glass colored by prejudice; he must view the evidence face to face, and be disposed to admit the truth, let it come from whatever source it may—let it lead to whatever results it may. He must be disposed to admit it though it compel him to give up favorite theories, and to break attachments formed even in youth.

“As the mere depression of the vital actions does not constitute

disease, so, conversely, the mere elevation of the vital actions does not; for if the vital actions of a patient left in a prostrated condition by an acute disease, be physiological, and be physiological still after he has gained his full vigor, it is evident that healthy action is not confined to any particular grade. The actions may not be diseased though depressed—they may not be diseased though increased, if *all* be proportionally increased or diminished. If, therefore, mere decreased or increased action does not constitute disease, why do these conditions so often accompany disease; or why do the ordinary causes of excitement and depression produce disease?

“ The answer to this question brings us to an important point in the subject now under consideration. The individual is composed of organs which are made up of tissues, the elementary parts of which are cells. The cells are the laboratories in the development of which all the vital chemical actions take place. It is the chemical actions which accompany their development from germs or granules, that constitute the sum and substance of organic life. The function of an organ is determined by the cells which compose it when placed under the proper conditions for their normal actions. Now, while every *germ granule* constitutes one condition for the development of a cell, still its normal actions are dependent upon other conditions furnished only by the *joint* agency of the whole individual; the *germ granule* is produced by the actions of a single cell, but the actions of this parent cell were dependent upon conditions afforded by the whole individual, of which it formed a very small part. The conditions, for which the development of cells from granules is dependent upon the individual, are a fluid plasma, oxygen, and heat. If all the above conditions co-exist in their normal state, life is inevitable, and the actions must be healthful. The laws of life are as invariable as the laws of inorganic matter. As a ball in motion can not deviate from a right line of itself, no more can a healthy living being depart from health without the force of some noxious influence. If a body be moved by the resultant of any number of forces acting in different directions, a *proportional* increase or diminution of all the forces would not change the *direction* of the moving body, but would simply affect its velocity; so, if *all* the conditions of life are *proportionally* changed, the actions will still be normal though increased or diminished according to the change of the conditions. It is evident, therefore, that the *derangement* of the conditions of life must be the cause of disease. Now, the ordinary cause of depression or of increased action is a change in only one or two of the conditions of life, and that change often only exerted over part of the individual. It is from hence that these states of system are so closely associated with disease, while they are entirely distinct

from it. If, therefore, it is the actions which accompany the development of cells from granules or germs that constitute organic life, it is plain that if oxygen and heat act upon these germs disproportionately to the plastic condition of the blood, there must be diseased action. It is plain that the conditions of decay may exist to a greater extent than the conditions of renewal, as the blood is elaborated by a long process and changes its plastic condition comparatively slowly, while the conditions of decay may be changed instantaneously. I think it will appear, therefore, that disease attended with excitement, or depression, consists essentially in the disturbed relation between decay and renewal, or oxydation and nutrition. It has been shown that if *all* the conditions of life were proportionally increased, the actions would still be normal; so, when oxygen and heat are increased—without which there could not be increased action—and there is abnormal action, it is inferred that this results from the want of a proportional increase of the plastic condition of the blood. This view will be confirmed by what is to follow.

“When the causes of inflammation are considered, it is observed that whatever cause tends to produce greater *decay* in a part than takes place in health, tends to produce inflammation in that part. To illustrate the position taken in this essay, that the forces which produce life actions are evolved in the decay of the organism, it will only be necessary to notice the increase of one of the conditions of life. Let us take air for instance. If *air* be admitted into a shut sac or tissue from which it is in health more or less excluded, inflammation is the result. We know if air be entirely excluded, there could be no decay or life in the part; if it be partially excluded, as it is from the internal parts of the body in health, decay must be limited in proportion. If now a free access of air be admitted to parts from which it had been partially excluded, decay increases above the natural standard in proportion to the extent to which the air had been naturally excluded; but the free access of air produces *inflammation*; therefore, increased action or inflammation is produced by increased decay or oxydation. If the surface be denuded of the skin, the most approved practice is to exclude the air, as far as possible, from the part affected, and thus prevent the increased decay, and consequently inflammation, which the free access of air would tend to induce. The coagulable lymph, first thrown out in a wound in contact with air, is converted into pus, which is a means of nature to protect the part from the influence of air. If the edges of a wound be brought together, so as to exclude the air as in nature, union may take place without inflammation; so, when inflammation does occur after a wound, it must be referred to some influence which did not exist in the case where a cure was effected without it. There is every reason to believe

that this influence is the air, which increases decay, and consequently causes inflammation. The fact that there is increased life-force where there is increased decay, makes inflammation a recuperative act, which otherwise would be only destructive. If life-force were not evolved by decay, the balance between decay and renewal would not be so constantly preserved as it is in health: in disease, it is the secret of the '*vis medicatrix naturæ*.'

"If life force be evolved by decay, there must be decay prior to life action. Now action is proportional to the force impressed, and consequently in health there would be a constant relation between decay and life action. If a body held together by cohesion be moved, *all its parts* must be moved together; if a slender cord be attached to a part of it, and a force be slowly and steadily applied, a body of heavy weight may be moved; but if the force were suddenly applied, the cord would be broken without moving the weight, because it requires *time* for the force to be brought to bear upon the whole mass; so if life force be *suddenly* applied to a *part* of the organism, it will produce disease, because it requires *time* to change the action of the whole machinery. Now, if life force is evolved by decay, and it requires time for this force to produce its legitimate action, if the conditions of decay be suddenly increased, it may go on to inflammation corresponding to the suddenness and extent of the increased decay before the actions of the whole system correspond to the rapidly increased force. In every living being there are two sets of actions constantly going on—one of disorganization, the other of organization. In health, organization is in proportion to disorganization, or decay; but, in health, organization is in proportion to the life force; therefore, life force is in proportion to decay, and it is inferred that it is evolved by decay. It is evident that decay is in no way dependent upon organization, except as it furnishes the material to decay; but decay may be increased suddenly, while the force thus evolved can not *instantly* pervade the whole system and raise the plastic condition of the blood, so that the organization in the *part* may increase proportionally and simultaneously with the increased decay, especially as the *whole system* is nourished from a *common* circulating fluid. And disease consists essentially in this—a disproportion between disorganization and organization.

"In cold-blooded animals, injuries are repaired *without* inflammation. This is just what would be expected *a priori*, upon the supposition that life force is evolved in the act of decay, and that inflammation consists in a disproportion between decay and renewal. For the act of decay it is necessary that the following conditions should co-exist: A material to decay, moisture, air, and heat; now in warm-blooded animals the morbid cause is like a coal applied to *dry* wood, which takes fire and evolves heat suffi-

cient to keep up its own combustion; but in the cold-blooded, it is like the same application to *wet* wood—the heat is absorbed in the evaporation of the water, and, consequently, the temperature of the wood is not raised sufficiently to cause its combustion. The temperature of these animals is not sufficient for much increase of decay, and increased decay in them would not increase the temperature; so there is no chance of those causes which produce suddenly increased decay in the warm-blooded animals, producing the same effect in the cold-blooded, and, consequently, there is no chance in them of that disproportion between decay and renewal which appears to constitute inflammation.

“Again, upon the supposition that all *morbid excitement* consists essentially in a disproportion between decay and renewal, and consequently that life force is evolved by decay, it would be expected that such excitement *might* exist in any condition of system or grade of vital activity; but it would be expected that slighter causes would produce disease in the debilitated, because slighter causes would disturb the balance in such a state of system. Now, let us consider the facts in the case. If an individual place his hand into warm water, he may, with impunity, gradually increase its temperature to an extent which would produce inflammation in a hand *suddenly* plunged into it. This is an example not only of the different effects produced by *suddenly* increasing the conditions of decay, and by increasing them to the same degree *slowly* and *steadily*, but it shows that the same cause which would produce *morbid excitement* in a part at the natural standard of vital activity, would not produce the same effect when the vital activity is increased. Again, if a part be much reduced below the natural standard by cold, a degree of heat which before would have been pleasant would now not only cause pain, but would actually produce inflammation. But a part even partially frozen may be restored to its vital activity without inflammation if the temperature be increased very slowly and gradually. These facts prove positively, it appears to me, that life force is evolved by decay; that it requires time for the force to produce its legitimate actions, as in physics; that over-excitement consists in a disproportion between decay and renewal; and that this disproportion is more easily produced the more the vital actions are reduced. Admitting the truth of the first conclusion, the other three would follow as natural consequences; so, observation, showing that morbid excitement is more easily caused by increasing the conditions of decay when the vital actions are depressed; that in morbid excitement there is greater decay than renewal; and that in all physics it requires *time* for force to overcome inertia, goes far to prove the truth of the proposition that life force is evolved in the decay of the organism.

“If morbid excitement consists in the disturbed relation be-

tween decay and renewal, it is evident that excitement may be produced either by increasing the conditions of decay, or by diminishing the conditions of renewal more rapidly than those of decay. The effect of increasing the conditions of decay has been somewhat considered already; it remains to notice briefly the effect of diminishing the plastic condition of the blood. The blood is both an oxydizing agent and the common pabulum of the whole system. It is thought that the constituent of the blood which conveys the oxygen to the tissues is distinct from the *nutritious* material; that the former is performed by the red corpuscles, while the fibrin is appropriated to nutrition. Now, while it is contended that *all* life actions are produced by forces evolved in decay, and that without decay the blood could not be elaborated, yet it is plain that there might be causes which would affect the *actions* without directly affecting the forces. For instance, no forces whatever could make proper blood from insufficient or unwholesome food; again, a morbid cause might be introduced into the blood which would first affect its plastic condition. But as decay evolves the forces to produce renewal, so renewal furnishes the material to decay; consequently, these two sets of actions are mutually dependent upon each other, and whatever would affect one, would secondarily affect the other. It is in this circle of action and dependencies that consists the *vis medicatrix naturæ*. The cause of disease, whatever it may be, disturbs the balance; the mutual dependence of decay and renewal upon each other causes a tendency to a restoration, and, as soon as this is effected, though the patient may be much debilitated, there is a change from diseased to healthy action. Now decay must be prior to renewal, or the force before the action; so, at the commencement of fever, decay may be as great as in health, but if the plastic condition of the blood is so deranged that renewal is less, the next act of decay must be less because the same amount of material to decay is not furnished; and if renewal is still less than decay, the next act of decay must be less than the former, and so on, the patient becoming more and more debilitated, though the cause of excitement will continue until the cause of disease is removed, and a restoration of the balance between decay and renewal is effected. However heavily this may grate upon the ears of those who are accustomed to look upon the *humoral theory* as entirely exploded, still there is sufficient evidence to prove that the condition of the blood has much to do with fever. Reasons will hereafter be given for the opinion that the actions of the heart and of the nervous system (other things being equal) are entirely dependent upon the conditions of the blood. The observations of Andral prove that the *fibrin* increases in simple inflammation much above the natural standard, while in continued fever it is much diminished in proportion to the red corpuscles.

“The proposition that *life force is evolved in the decay of the organism*, is confirmed by the means which nature takes to cure disease, or by the observed natural tendency to health. The fact that in inflammation the blood becomes more and more plastic, proves that the forces which produce fibrin are increased in inflammation; that is, the increased disintegration increases the plasticity of the blood, or the very act which increases the demand increases the forces to supply it. But, in inflammation, renewal is not so rapid as disintegration; therefore the material to decay is constantly becoming less, while the plasticity of the blood is constantly increasing; so, here is the tendency to an equilibrium, or a balance between decay and renewal. So, in continued fever, where the morbid cause resists the efforts of nature, the fever and excitement show that she is making these efforts to restore the equilibrium, and so soon as the cause of disease is removed she will accomplish her object, as life force increases and diminishes with decay. If any cause should increase decay, there is a recuperative action set up in the system; for the same cause would indirectly increase life force; if any cause diminish decay, there is also a recuperative action set up; for the same cause would diminish life force accordingly, and consequently the structure would be more easily influenced by the ordinary conditions of decay.

“Again, the evidence in favor of this proposition derived from reaction and remission must not be passed over without notice. ‘Excitability’ is a word used to express an hypothetical agent supposed to reside in the system and produce these phenomena. It is fancied that excessive action *exhausts* this excitability, while it is recruited by repose. Observation proves that excessive action is followed by a state of depression, and depression by increased action, but the received notions about excitability as an agent producing these phenomena are but flights of the imagination. The explanation explains just nothing at all, because the essential part of it is altogether hypothetical and mysterious. The objections which were brought against the ‘vital principle’ under the head of Dormant Vitality, hold equally against ‘Excitability;’ that is, against the ideas which excitability is used to express. When a part has been exposed to severe cold, it is said to be more easily excited because its excitability is increased by repose: would it not be better to give the old woman’s explanation in simple terms?—‘It is so because it is!’ But the word is not confined to this simple meaning; it is used to express an independent agent supposed to be the efficient *cause* of reaction and remission—of excitement and depression, as it is capable of becoming tired and recruited again. The following is found in one of our most popular text books: ‘It must be admitted that the system has a limited *amount* of excitability; but it is not

true that the *whole* of this excitability is called into play in health. It is easily conceivable that, by augmenting the *stimulation* applied to all the organs, the excitability in reserve may be *brought* into action.' It is apparent from the above phraseology that the word excitability is very convenient to explain much, but I confess my inability to conceive how 'excitability in reserve' can be stimulated into action, as it is a *passive quality* and not an *active agent*. Water is expansible by heat into steam, but heat does not *stimulate* its expansibility into action. If the heat be increased, the expansive force of the steam is increased, but the heat is not a stimulation by which the expansibility *in reserve* is brought into action—heat is the *force* which *produces* the expansion. Now, heat is evolved by the oxydation of combustible matter; increase this oxydation, and all the actions dependent upon the force of heat are increased accordingly; but an increase of the *conditions* of combustion, such as fuel, oxygen, &c., does not stimulate the expansibility of steam *in reserve* into action—it simply increases the force upon which the actions depend. So in the organism, I contend that the conditions of life do not *stimulate* excitability into action, but they produce oxydation or decay by which the forces are evolved which produce life actions. Increase these conditions, and life force is increased, and, consequently, life action; hence the susceptibility of the organism to oxydation or decay gives to it the property of excitability. All action is in proportion to the force impressed; so when action is increased, the force is increased and not stimulated. Hence, those agents called "Vital Stimuli" do not stimulate life force or "Dormant Vitality" into action, but they induce the oxydation of the organism by which those forces are evolved which produce life actions.

"Reasoning, *a priori*, from the theory that life force is evolved by the oxydation of the organism, exacerbation and remission, depression and reaction, would be expected when the equilibrium should be disturbed in disease, from the fact that the same cause which increased decay would indirectly increase life force, and the cause which diminished decay would diminish life force; and from the fact that depression and excitement consist essentially in a disproportion between decay and renewal. The important points pertinent here, have been already sufficiently noticed and need not be repeated."

If the reader will take the trouble, at this point, to compare the paper in the British and Foreign Medico-Chirurgical Review referred to, with the above, he will find a very *remarkable* similarity. I here make a few quotations, (see July No. 1858, p. 159.)

“All writers on inflammation have recognised in it processes of two opposite characters and tendencies. Mr. Paget classifies them into those that are productive, and those that are destructive, and the distinction is broadly obvious. Into the ordinary conception of nutrition itself indeed both these processes enter; it is regarded as including two opposite actions or series of changes—growth and decay. But this oppositeness of action is even more marked in inflammation than in health. In an inflamed part we may see a structure decomposing, not in invisible molecules, or by mere interstitial removal of its elements, but dying in large masses, while all around it the evidences of *vital* action, of the impetus towards growth, are seen in more than ordinary energy. Is there any intimate relation between these opposite actions; may inflammation consist in either alone; or, if both be essential, what is their connexion?

“That an increase of both processes, the decay and the vital action, is necessary to constitute inflammation, appears when we consider the distinctive characters of that affection. It differs from mere increased decay, as primary gangrene or atrophy, on the one hand; and from mere increase of vital action—hypertrophy, repair, or development—upon the other. Its peculiar characters involve at once an abnormal increase of destruction and of growth.

“If, then, both these changes be essential to inflammation, can there be traced between them any other connexion than that of co-existence? Are they related as cause and effect? Which is the starting-point of the morbid process?

“I answer: they are related as cause and effect; the increased decomposition is the starting-point; the increased vital action is secondary and dependent.

“The first proof of this position is found in the nature of the causes by which inflammation is induced. All of these, it has often been remarked, are such as clearly tend to lower the vital power or to produce actual destruction of the parts on which they act. In every case in which the origin of inflammation is distinctly traced, the starting-point is found to be in fact an anti-vital change.

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“Connecting thus the two series of changes, destructive and formative, as cause and effect, both may be understood. For the increased formative action some cause is demanded, some additional and locally acting force to which it may be ascribed. This demand is fulfilled by the increased decomposition, which is a known source of force, and which is itself sufficiently accounted for by the tendency of all organized substances to undergo decay. The abnormal decomposition is referable to known and sufficient causes, and itself supplies a cause for the abnormally increased activity of the formative process.

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“The twofold nature of the processes concerned in inflammation has been one chief source of the difficulty that has invested the subject; these processes not being seen in their true relation, nor recognised as corresponding, in respect to that relation, to the healthy life. Two opposite views have been maintained by different writers, each with great support from observation, yet each failing to supply a theory of the affection that could be accepted as complete, or as applicable to all cases. On the one hand is the theory of ‘increased action;’ on the other, that of ‘debility,’ or diminished vital force. Each reposing on one portion of the phenomena, with an insufficient recognition of the other, and embarrassed, therefore, instead of aided, by half of the facts with which it had to deal; each capable of a most plausible demonstration, yet leaving in the mind a painful consciousness that the problem was not solved, nor the true nature of the disease revealed. The old theory of increased action demanded as its complement the modern one of debility or diminished action; but the latter, though more philosophical, equally fails to express the whole truth, and had it existed first, would not less certainly have been supplemented and supplanted by the one whose place it has usurped. If inflammation be in all cases merely diminished action, ‘depression of the vital force,’ what is the distinction between sthenic and asthenic inflammation? why should stimuli be in some cases useful, in others injurious? Would not the term, ‘diseases of debility,’ become then a mere pleonasm, while yet we can not but feel that it does express an actual and most important distinction between classes of disease which may be both alike inflammatory? And are not greater heat, more rapid circulation, a more vivid sensitiveness, among the indications of a higher life by which the warm-blooded animals are elevated above the cold-blooded? Shall we, to make a theory consistent, permit contradictory interpretations of identical phenomena?

“Let me not be misunderstood. I do not deny that inflammation is, in one sense, always a disease of debility; that is, its starting-point is an anti-vital change, it originates in decay; but it includes not less an opposite class of actions, the downward process generates an upward one; decomposition adds intensity to life.

“The inflammatory process, then, is an affection primarily due, as all functional processes are, to a disintegrating change which generates a formative process that would not else exist. Thus viewed, inflammation may not only be better understood in itself, but may be brought into definite and intelligible relations with a wide circle of kindred phenomena, mutually giving and receiving light. And first, as to its own nature, it is found to bear a distinct and decisive character. It may be defined. The

boundary which separates it alike from health and from other morbid processes is distinct and legible. From health it is distinguished in this, that it is an excess or perversion of the *functional* activity, with its consequences; the decomposition which is normal in function exceeds in inflammation that amount which is compatible with the integrity of the tissues.

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“ But though the connexion of inflammation with various diseased conditions has embarrassed the interpretation of the phenomena, by leading men to mix together in their thoughts elements that required to be distinguished, yet it affords an insight, hardly else to be obtained, into the use and meaning of that process in the animal economy. For, if the decomposition of the tissues in inflammation be a source of increase in respect to the vitalizing action, an immediate utility becomes evident in it. In diseased conditions of the system, the vital power is depressed; in the inflammations to which they give origin there is a source of increase of the vital power. Certain textures fail in their vitality owing to the defective vitality of the whole, and that failure is attended with chemical processes in them, which generate in their reaction an increased energy of vitality. In a word, inflammation, destructive as it seems, is in one point of view strictly a conservative and remedial process. In respect to the individual, it is the sacrifice of a less for a greater good. The benefit of it is often very evident, as when a blister induces healing of an indolent ulcer, or mechanical irritation the union of old-standing fractures. It is indeed from such cases as these that the theory of ‘increased vital action’ draws its chief support; for, as a fact, such increase is in these cases undeniable. But though less obviously, yet not less truly, I conceive, is the reactive process in inflammation in every case a salutary, that is, a saving or restorative process. That we do not see it so, is that we do not sufficiently perceive the elements involved in the case. We do not carry our thoughts back to the loss or defect of the vital power which necessitates it, and to which it stands in the relation of a remedy or amelioration. Doubtless it is an evil; so is a forming callus, or a granulating wound. But these are less evils than a useless limb or torpid sore, and so is inflammation a less evil than the mere decay and loss which would be without it. It is ever to be remembered that the symptoms of increased activity in the inflammatory process can never go beyond their cause, can never exceed the defect of vitality of which they are at once the effect and the sign. How violent soever or injurious in their results, the evil is not in them, but in that approximation to death for which they are the divinely appointed and only remedy. True, the results are often disastrous, the materials effused in inflamed organs may interfere with essential functions, or the ex-

citement of the general system may exhaust the powers. But this is because the loss of vitality has existed in a great degree, or has affected a texture of primary importance. An organ that has suffered inflammation is a damaged organ, but it is a better one than if it had not inflamed : a constitution may thereby be weakened, but it might otherwise have sustained a severer injury. So far as is possible, inflammation restores a life that has been lost : it adds to vitality, not detracts from it ; loss of vitality is its starting-point, but not its essence. I do not deny, indeed, that the effects of the inflammatory reaction may be injurious, and in a secondary way, as by mechanical pressure or otherwise, may give rise to evils serious or even fatal ; nor that it may be wise in many cases to seek to moderate or subdue it. These are questions which experience must decide ; they do not affect the physiological significance of the process."

I hope the reader will be sufficiently interested to read carefully this whole paper of Dr. Hinton. Enough has been quoted above to answer the purpose of this essay, which is neither to *prove* the position nor to establish my priority, (men must believe a thing valuable before they care to whom it belongs,) but rather to excite sufficient interest that its value (which I sincerely believe it contains) may be established. Dr. Hinton presents a theory of inflammation which *he* contends is clear and satisfactory, and embraces the phenomena as no prevailing theory can pretend. The British and Foreign Medico-Chirurgical Review publishes it under the head of "Original Communications," and in this declares it at least worthy of consideration. But, nearly eight years earlier, I deduced this same theory of inflammation from a general idea of the conditions and laws of organic life. How much more worthy of consideration, therefore, is that idea of Life which embraces this same theory of inflammation as a very small part. More especially, too, as it must be admitted by all, that a true theory of inflammation must be embraced by a more general theory of Life. I care nothing for this theory of inflammation further than it embraces the facts, and is itself embraced by a more general idea of Life which I sincerely believe true.

There is another point worthy of notice ;—I sent the pamphlet on "Organic or Life Force" to the British and Foreign Medico-Chirurgical Review soon after its publication ; but it received no attention. Probably it would not have been becoming me to say that nevertheless it was worthy the notice even of that journal, though an inaugural thesis, had not the theory of inflammation

therein contained (an application of the leading idea and really of minor importance) been found worthy to appear some seven years after under the head of "Original Communications." The "American Journal of Medical Sciences" noticed my essay very favorably;* and after having occupied over eight of its pages with extracts, (which alone I appreciate as a high compliment,) it continues: "Many views of a highly interesting character are presented by him," (Dr. Watters,) "either arising out of his leading proposition, or adduced as additional evidence of its correctness, which we have not noticed; the true value of these can not, in fact, be well appreciated, excepting they be studied in the order and connection in which they occur in the essay before us." This theory of inflammation was *one* of the "many views of a highly interesting character" referred to as "either arising out of his leading proposition, or adduced as additional evidence of its correctness." As the British and Foreign Medico-Chirurgical Review, therefore, found this view of inflammation sufficiently interesting to appear under the head of "Original Communications" when presented by Dr. Hinton, certainly I do not subject myself to the charge of egotism when I proclaim aloud and to the world, that there is *possibly* something in that "leading proposition" contained in the "Essay on Organic or Life Force," and in this series of articles, worthy of consideration.

Moreover, I hesitate the less to express myself thus freely because this is not the only view in my thesis, arising out of the leading proposition, which has since been presented by others. Dr. Draper, in his late work on "Physiology," says: "We probably shall not be very far from the truth if we assert that *muscular contraction is the necessary physical result of muscular disintegration*, and without here considering the various ways by which that muscular disintegration may be brought about, such is the doctrine I now present." This "doctrine" is emphatically presented in my thesis, as well as in the last No. of this series of articles; and it must be apparent that whoever goes thus far with me, is bound to admit that muscular contraction is regulated by conditions which regulate muscular disintegration; and hence, that so far as the nervous system regulates muscular contraction it *must* do so by regulating muscular disintegration, and that so far as muscular contraction is independent of the ner-

* See July No., 1852.

vous system, (the heart, for instance,) so far muscular disintegration *must* be regulated by conditions other than the nervous system.

In fact *every* physical phenomenon indicates to me, as its primary condition, not *Force* or *Law*, but Form and Motion. When this is applied to vital phenomena, we have special forms (internal and external) to determine the special modes of motion, and antecedent motion to determine the motion: not motion metamorphosed into heat, light, or electricity, which are forms and not motion; nor into vital force, which is a fiction without form or motion. In a living organism, the special modes of motion to which we apply the term Vital, are reciprocal with disintegration, which is the vital motor. To behold the facts from another point—the whole physical universe is *one* vast Form, in Motion—the human body is not isolated, but is an integral part of this universe in motion. The special *mode* of motion of the physical universe and of every integral part,—of the human organism as well as of the plant and of the crystal, is determined by the special Form. But to continue:

If the theory of inflammation presented by me in the “Essay on Organic or Life Force,” and by Dr. Hinton, be true, it is a strong verification of the leading proposition that disintegration is the vital motor. I will now, therefore, present additional evidence of the correctness of this view of inflammation, (which I have before presented on various occasions but never published,) that the presumption against the “leading proposition” may be at least sufficiently removed to secure for it that consideration which I conceive its importance demands. The full force of the argument used in favor of this theory of inflammation can not be appreciated, unless the respective functions of the inductive and the deductive methods of reasoning in the physical sciences be at once recognized. With Dr. Hinton, the position that the increased action of inflammation is the *effect* of increased decay, is an induction; with me, the position that the phenomena of inflammation depend upon a disproportion between decay and nutrition, is a deduction from the general proposition that decay is the vital motor, and this, from the more general one that Form and Motion are the primary conditions of every mode of motion in physical nature. Hence, the question considered by me is, upon the supposition that decay is the vital motor, can the phenomena of inflammation be explained? if so, then this deduction

is a strong verification of the general proposition. If the phenomena of inflammation justify the induction of Dr. Hinton, how much more do they justify this deduction? for, a class of facts which alone might not be sufficient for an induction, might be quite sufficient for a deduction,—to confirm a position already arrived at by induction from other facts. But Dr. Hinton thinks the facts of inflammation are sufficient for an induction; in fact, by induction he arrives at the same theory of inflammation which I did by deduction: what greater verification than this could there be? And he presents the same class of arguments too, as sufficient for the induction, which I presented in my thesis to establish only a deduction. This is really a greater verification than I expected so soon. But to proceed to additional arguments:

Every *portion* of the human body, equally with the polyp or a plant, possesses its own conditions to determine its special vital motions, (see article No. VIII, of this series, St. Louis Medical Journal, Sept., 1855.) The polyp may be divided into an indefinite number of pieces, and each piece will continue to live because proper fluid plasma and the other essential conditions of life are furnished from surrounding circumstances the same as before when the parts were united. But in the higher animals the fluid plasma is more special, and can be secured to each part in proper quality and quantity only by the joint action of the special systems of their bodies. It is from hence that a portion separated from the rest of the body will not continue to live, though it possesses within itself that which determines its own mode of motion as much as do the different parts of a polyp. But, as we can “bud” a plant, so we have successful plastic operations in surgery in consequence of this fact.

Fluid plasma is an essential condition of life because of the demand occasioned by waste or decay, which is in amount always proportional to the vital motions. The various tissues and organs of the body differ in rate of disintegration, but the vascularity of each part corresponds to its functional activity. I know that physiologists are accustomed to consider the waste as consequent upon the functional activity, and the functional activity upon the vascularity. This relation is assumed, I say; but this fact itself,—that waste, functional activity, and vascularity are proportional,—is equally consistent with the position that decay is the vital motor.

But there are many phenomena co-ordinated by the position that decay is the vital motor, which are altogether inexplicable upon, and inconsistent with, any other supposition. It is most true that the blood is the carrier to every part of the body, not only of fluid plasma which is a condition of nutrition, but of oxygen which is a condition of disintegration; but this does not, by any means, establish the position ordinarily assumed. It is equally true, that heat and oxygen are conditions essential to the combustion of wood under the boiler of a steam engine, but the combustion itself determines the heat and the supply of oxygen or the draft; and we can easily conceive such a form or adjustment that the amount of fuel, too, would be thus determined. As every motion in connection with the steam engine is reciprocal with the oxydation, or combustion, or the "downward" action, whatever you choose to call it, so, I am persuaded, is every vital motion and even the "draft" or supply of oxygen and fluid plasma. And I do contend most strenuously that every fact connected with inflammation is consistent with this position, while many are altogether inconsistent with any other which has been, or may be, taken.

The functional activity of the muscles, the brain, and other organs may be increased, and this increase of functional activity is always proportional to increased waste or disintegration. But when we exercise the muscles or the brain, there follows an increased flow of blood to these organs in consequence of the waste. The decay or waste creates the demand for fluid plasma, and is the condition which determines the supply; at least the facts agree with this view. And it would seem difficult, upon any other view, to account for the constant relation preserved in health between the demand and the supply. Besides the *vis a tergo*, (and the power of the heart, too, is reciprocal with the oxydation,) a capillary power is well made out and established. But this "capillary power" is assumed to account for capillary circulation, local changes, &c.; now, whatever causes tend to increase oxydation or disintegration increase the capillary circulation, and whatever causes tend to decrease oxydation decrease the capillary circulation; hence, oxydation or disintegration is the primary condition of capillary power. "*Ubi irritatio ibi fluxus*," I translate,—wherever there is increased disintegration there is increased flow of blood. This is a true rendering of nature, if not of the Latin.

Congestion is so essential a phenomenon of inflammation, that inflammation has been defined "active congestion and its results," (see "Outlines of Pathology," by Prof. Linton.) As, for a clear understanding of "active congestion," we had to go back to its conditions, so here, we must go back to the conditions of "its results."

Though each part of the body determines its own mode of vital motion, yet the fluid plasma is common; the standard of which, and the amount furnished to each part, in health are such as to meet the ordinary demand. When there is increased disintegration in a part, the increased demand may be met within certain limits by the increased supply of plasma at the ordinary standard; but when these limits are exceeded, then it is we have the phenomena of inflammation. There are various degrees of disproportion between the demand and the supply, being limited upon one side by healthy nutrition, and upon the other by mortification. The causes of increased disintegration in a part may be great and sudden; nature attempts to meet the increased demand for plasma by the increased capillary power, of which the disintegration itself is the primary condition. But beyond certain limits, the attempt must fail from the very nature of the case. And how various soever may be the conditions which occasion this failure, under each and all we have the phenomena of inflammation.

If parts of the body, the hands or feet, for instance, be exposed to "cold" for some length of time, the disintegration must diminish in proportion to the diminution of temperature; and, consequently, the capillary power and circulation diminish proportionally. Now, the application of only a moderate degree of heat externally, will occasion inflammation; not because the disintegration thus produced is above the natural standard, but because the supply of plasma has been cut off by the continued action of cold, and can not be so suddenly furnished to the surface upon which the external heat acts. When a part is in this "frosted" condition, it would probably be as much *scalded* by water at the temperature of 100 degrees, as in its ordinary condition it would be by boiling water. Again, we may immerse a hand or foot in warm water, and with impunity gradually raise the temperature to such a degree as would occasion inflammation in the other hand or foot if suddenly introduced. In the one case, there is *time* for the increased disintegration to be met by a corresponding increased supply of plasma; in the other, there is not. The

same thing is illustrated again by this class of facts ;—the finger may be with safety introduced into water so hot that inflammation would be occasioned if the whole hand or arm were thus immersed. The reason is clear ;—an increased demand for plasma in a small part of the body, can be more suddenly met than when the same demand is occasioned in a greater extent of surface. But it is unnecessary to dwell upon this point.

Just as external causes acting upon the body may occasion inflammation either by increasing disintegration or by diminishing the supply of plasma, so, various states of the blood may occasion the same primary conditions of inflammation. Substances may be introduced into the blood, or substances may be formed in the blood and not eliminated, which cause increased disintegration in certain parts ; or, the plasma may be lowered in standard or variously perverted as probably in erysipelas or typhus fever. Hence, Inflammation is associated with almost every variety of disease.

But in considering the *classes* of circumstances which may occasion the primary conditions of inflammation, we must not leave out the influence of the nervous system. Disintegration is to a certain extent regulated through nervous conditions. The oxydation of muscles (with consequent contraction), for instance, is regulated through the nervous system. One may study (every thought being accompanied with disintegration of nervous matter) until inflammation of the brain shall be induced.

But these three classes of circumstances are most frequently combined in the production of inflammation. How great soever may be the variety of influences which conspire to produce inflammation, they all do so by occasioning a disproportion between disintegration and nutrition. The facts, at least, so far as I can trace them, seem to co-ordinate with this position.

The next position to be considered is :—If disintegration be the vital motor, then, not only the supply, but the production and standard of the plasma, must depend upon disintegration. Let us examine how facts co-ordinate with this position. The object of nutrition being to preserve the organism, in health the elaboration of plasma must correspond to the waste. If the elaboration of plasma, with all *vital* motions, is reciprocal with disintegration, this constant correspondence is made intelligible.

Hibernating and cold-blooded animals remain in a death-like torpor during winter. Whatever may be considered the relation and dependencies of vital motions and disintegration, it is a fact

that the torpor is a direct index of a corresponding limited waste. As the external temperature is elevated the vital motions increase, and the demand for food and the elaboration of plasma also increase proportionally. Variations of temperature is the prime condition of the different conditions of these animals in winter and summer. But heat tends to occasion disintegration in organic matter, and the fact is that in these animals disintegration is proportional to the heat. Now, as disintegration, vital motions, demand for food, and elaboration of plasma, are all proportional, and as heat, which tends to occasion disintegration, regulates these, it seems reasonable to infer that disintegration is the prime motor in living beings. To avoid this natural conclusion it has been customary to assume that heat *stimulates* a "dormant vitality," and that disintegration is in consequence of the exhaustion of vitality. All this has been sufficiently considered in the *inductive* portion of the argument, and consequently it is only necessary here to establish that facts *co-ordinate* with the position that disintegration determines the elaboration of plasma. Certainly it is a fact that the plasma is elaborated in these animals in proportion to the disintegration occasioned by heat. The same fact is illustrated in all animals, and is only more prominent in these because great variations are occasioned by heat.

Again, it is well known that exercise is a *tonic*. One confined becomes debilitated, but exercise in the open air invigorates. Yet exercise is attended with corresponding waste, making the demand for plasma proportionally greater. When a patient is already badly nourished, you order him to take exercise in the open air that his strength may improve; that is, you order him to increase his waste that he may be the better nourished. This is most paradoxical, but your patient improves under the treatment. It is said that the tonic effect of exercise is *because* it increases all the functions; that is, it is a tonic because it is a tonic. But, remember, your prescription was to increase disintegration; the facts accord perfectly with the position that the increased action of the heart, the increased capillary circulation and the improved plasticity of the blood, are consequent upon the increased oxydation.

Moreover, it is especially necessary that children, when growing rapidly, should take exercise; their instincts prompt them to it. But interstitial change in the child already is much greater than

in the adult, yet when plasma is required not only for nutrition but for growth also, disintegration must be still increased in almost constant exercise, to secure health and vigor. But you say, exercise stimulates the vital functions;—what do you mean by “*stimulates* vital functions?” To account for the disintegration in proportion to exercise, you have just said that the vital force is exhausted in gross motion, and, that consequently a corresponding amount of muscular tissue is given up to chemical forces; and now, you say, exercise stimulates the vital functions! What do you mean? Look to it, what idea have you under this thick verbiage? Is it not but a cant phrase used without any distinct meaning? Facts *do* agree with the position, however, that the vital motions depend upon oxydation, and that exercise is a tonic because of the increased disintegration.

It does not seem necessary to multiply examples of this position; the fact that the plasma, in quantity and quality, corresponds to the demand in health, and, in disease, that there is a natural tendency to health—a return to normal conditions,—co-ordinate perfectly with the position that the elaboration of plasma, as well as other vital motions, depend upon disintegration as the antecedent motor.

But, if the elaboration of plasma, therefore, depends upon oxydation as the vital motor, and if the phenomena of inflammation are consequent upon an excess of disintegration over nutrition, then the plasticity of the blood must be increased in inflammation; at least, this must be the natural tendency in the inflammatory process. So, if there be increased disintegration in a part, there is in consequence, in the first place, an increased flow, to the part, of blood at its present standard corresponding to the ordinary waste; in the second place, the plasticity of the blood also is increased in consequence of the increased disintegration; and from this results a tendency to health or to a return of normal conditions. Let us now see how facts agree with this latter position.

Not only is the plasticity of the blood increased with muscular exercise, and in proportion to the disintegration occasioned by heat, as noticed especially in cold-blooded and hibernating animals, but it is a fact also that the plasticity increases with the inflammatory process. This is admitted by all who believe *Fibrin* to be a histogenetic substance. And, remember, in other in-

stances where we found the elaboration of plasma to correspond with disintegration, the conclusion was in no way dependent upon our notions of what may, or may not, be the peculiar plastic substances. I will not, therefore, attempt to prove here that Fibrin, which is admitted to increase greatly in "healthy inflammation," is histogenetic (especially as the burden of proof is upon those who deny it), but will merely notice the arguments of those Pathologists who contend that it is effete matter.

The arguments of these Pathologists go to establish two points; the first is, that Fibrin is not the *only* plastic substance,—that there may be life even without it, as there is none in the egg. No one denies this position that I know of, and so far as arguments which only go to establish this point are used to establish that Fibrin is excrementitious, it is a most apparent *ignoratio elenchi*. The second point which their arguments go to establish, is, that the production of fibrin "is to be traced to the process of disintegration and waste." It is a most apparent *non sequitur* to conclude from this that fibrin "must be considered an excrementitious product, derived from the waste of the tissues or the oxydation of the blood, and in process of elimination from the system." It is admitted that there is a strict relation between the amount of disintegration or waste and every vital process; consequently, the same relation being traced between disintegration and the production of fibrin, by no means so much as indicates that fibrin is excrementitious. It is argued, because the production of fibrin is to be "traced to the process of disintegration and waste," that therefore fibrin is effete matter. I reason thus rather,—the production of fibrin is to be traced to the process of disintegration and waste; but fibrin is a histogenetic substance and its production must be a vital process; therefore *this* vital process is to be traced to disintegration and waste. The arguments of Zimmerman and Simon do not establish *their* position, but, so far as they prove any thing, they prove the position taken in my thesis and in this series of articles,—that disintegration is the vital motor. It is apparent that the facts embraced by their theory are equally embraced by the position here taken. It is contended by no one that fibrin is the *only* plastic substance in the blood; hence the fact that the proportion of fibrin is not diminished in the blood of animals reduced by starvation, does not prove fibrin not plastic; unless the fact that an animal will

die of starvation if fed exclusively upon albumen, proves albumen not nutritious.

I only consider fibrin here as an *indication* of the increased plasticity of the blood in inflammation; not intending to imply that its increased plasticity is solely due to the increased fibrin. I suppose that fibrin itself exists in different degrees of plasticity. I think it will appear that the phenomena of inflammation, so far as considered, at least, agree with the position that disintegration is the vital motor, and that the primary condition of the inflammatory process is the excess of disintegration beyond the supply of plasma of the proper standard.

It would not be expected that bleeding would diminish the proportion of fibrin in inflammation except so far as it might diminish the inflammation—*burning, oxydation*. And it is fortunate for the patient that bleeding does not otherwise diminish the standard of plasticity. When the system is so deranged, or poisoned, if you please, that the plasticity of the blood does not increase proportionally with the disintegration, blood-letting can not be resorted to with impunity. And in this condition of system, wounds, surgical operations, or any occasion of inflammation, are much more serious in their consequences than when they occur to individuals in otherwise good health. Hence it would appear that, so far from the increased fibrin being a cause or primary affection in the inflammatory process, it is the means of cure.

As an elevation of the standard of the plasma is one condition of cure, and as the whole system is supplied by a common pabulum, it would seem unnecessary always to allow the burden of increasing the plasticity to rest with the original inflammation (*burning*,) especially when an internal vital organ is involved; might not this office be in part vicariously performed by an inflammation “excited” upon the surface? This would seem to be one of the chief advantages of a Blister. In directing attention to this as one chief indication for the use of blisters in inflammation, however, I do not wish to imply that they are not to be considered otherwise beneficial too, especially through nervous connections. It has already been contended, especially in the last No. of this series, that oxydation or disintegration is to a certain extent regulated though the nervous system. Hence, certain states of the nervous system have been spoken of as conditions which may occasion, or

at least localize (if I may use the expression), inflammation. It has been pointed out, that through the nervous system oxydation, and consequent contraction, may be occasioned in this muscle or that, according to certain conditions; but the experiments of M. Claude Bernard show that, when a sympathetic nerve is cut, there follows increased heat and congestion in the part to which it was distributed. According to the views already advanced, we would say that when a sympathetic nerve is cut there is increased oxydation or disintegration in the part to which it was distributed, and, consequently, congestion and increased heat. But the experiments of Bernard also show that when electricity is transmitted along the cut nerve, the increased disintegration, and consequent congestion and increased heat, subside, and that the part returns to its normal condition. Now, the electricity used in Bernard's experiments was "developed" in the *oxydation* of zinc and transmitted to the nerves by copper wires. Is it therefore unreasonable to infer that, when an internal organ is inflamed, the oxydation upon the surface of the body occasioned by a blister may substitute the oxydation of zinc, and that the nervous connections may substitute the copper wires of Bernard's experiment?

But, it may be said, if the increased plasticity of the blood is a condition of the cure of inflammation, how does mercury promote a cure when its acknowledged tendency is to *defibrinate* the blood? The only answer I deem it necessary to give to this question here, is,—you say, mercury diminishes the plasticity of the blood, and therefore cures inflammation; I say, mercury diminishes the inflammation (*burning, oxydation*), and therefore diminishes the plasticity of the blood. Now, if at the same time you give mercury you apply a blister, you meet the two indications for the cure of inflammation. I do not wish to be understood as recommending the use of these agents in all inflammations; my only object has been to show that their remedial action, when indicated, accords with the position here taken in regard to the primary conditions of the inflammatory process.

In conclusion, I would beg leave to remark, that in regard to the ideas and positions presented in my thesis and in this series of articles, I have never asked any favors; I have received patiently all criticisms, public and private, just and unjust; but whenever these views are received as true, I certainly ask, not as a favor but as just and right, due credit. And whenever and wherever these views are endorsed, I shall *demand* proper acknowledgment equally as if they had been presented to the world in the more imposing form of a well bound book.

